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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/002,316	10/25/2001	Robert G. Tryon III	10652-004-999	2981

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EXAMINER	
FERRIS III, FRED O	
ART UNIT	**PAPER NUMBER**
2128	

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Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary	Application No. 10/002,316	Applicant(s) TRYON, ROBERT G.	
	Examiner Fred Ferris	Art Unit 2128	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *25 October 2001*.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1-37* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *1-4,8-13,19-22 and 26-37* is/are rejected.

7)☒ Claim(s) *5-7,14-18 and 23-25* is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☒ The drawing(s) filed on *25 October 2001* is/are: a)☒ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)

2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)

3) ☒ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08) Paper No(s)/Mail Date *3/6/02*.

4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____ .

5) ☐ Notice of Informal Patent Application (PTO-152)

6) ☐ Other: _____.

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DETAILED ACTION

1. *Claims 1-37 have been presented for examination based on applicant's disclosure filed on 25 October 2001. Claims 1-4, 8-13, 19-22 and 26-37 have been rejected by the examiner. Claims 5-7, 14-18, and 23-25 are objected to but would be allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claims. (See allowable subject matter below)*

Drawings

2. *Applicant's drawings submitted on 25 October 2001 have been approved by the examiner.*

Claim Rejections - 35 USC § 103

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

The factual inquiries set forth in *Graham* **v.** *John Deere Co.*, 383 U.S. 1, 148 USPQ 459 (1966), that are applied for establishing a background for determining obviousness under 35 U.S.C. 103(a) are summarized as follows:

1. Determining the scope and contents of the prior art.
2. Ascertaining the differences between the prior art and the claims at issue.
3. Resolving the level of ordinary skill in the pertinent art.
4. Considering objective evidence present in the application indicating obviousness or nonobviousness.

3. Claims 1-4, 8-13, 19-22 and 26-31 are rejected under 35 U.S.C. 103(a) as being unpatentable over "Probabilistic Fatigue Life Sensitivity Analysis of Titanium Rotors", M. Enright, Southwest Research Institute, American Institute of Aeronautics, 2000, in view of "Fracture Mechanics Analysis in DARWIN" Southwest Research Institute, 4th Annual FAA/USAF Workshop, December 1999.

Independent claim 1, for example, is drawn to:

<u>method for predicting component failure by</u>:

- obtaining Finite Element Model (FEM) of component;
- analyzing FEM to obtain stresses at nodes;
- identifying subset of nodes based on stresses;
- determining Representative Volume Element RVE for nodes;
- developing RVE microstructure-based failure model for RVE;
- simulating component life RVE microstructure-based failure model (component life);
- performing simulation to produce component life;
- preparing statistics;
- comparing statistics probability of failure (POF) criteria to determine predicted failure for component.

<u>Regarding independent claim 1</u>: Enright teaches a method and system (DARWIN) for predicting the failure of a component (structure) by representing a component element within a Finite Element Model (FEM) and subsequently identifying node stresses by analyzing the FEM model. (page 1, para: 3, page 3, para: 3-5, Tab. 1) Representative Volume Elements (RVE) are commonly used in FEM modeling, and hence would have knowingly been incorporated by a skilled artisan to represent a microstructure failure model. (See: Smit, para: 3, for example) Enright further discloses simulating a structures life (in this case a rotor) to predict failure (page 4, para:2 to page8, para: 1, Figs. 5-9) and using model statistics and probability. (Also see: Abstract,

Introduction, Figs. 2, 4, 5-7, page 1, para: 2)

Enright does not explicitly teach fracture mechanics in comparing the statistics to a probability of failure criteria.

McClung also teaches a method and system for predicting failure of a component represented in a FEM model inclusive of stress modeling and analysis and simulating component life. (pages: 1-7) More importantly, McClung teaches the use of fracture mechanics (crack growth mechanisms) and considers the spatial correlation of regions for different geometries and damage mechanisms in calculating (by comparison) a component probability of failure. (pages: 8-14)

It would have been obvious to one having ordinary skill in the art at the time the claimed invention was made to modify the teachings of Enright relating to for predicting the failure of a component by representing a component element within a Finite Element Model (FEM), with the teachings of McClung relating to the use of fracture mechanics in comparing the statistics to a probability of failure criteria, to realize the claimed invention. An obvious motivation exists since, in this case, the Enright reference teaches to the McClung reference, and the McClung reference teaches to the Enright reference. Specifically, both Enright and McClung teach failure analysis using FEM models and the DARWIN system and are used in the same technological arena as noted above. Enright teaches to McClung because Enright teaches modeling component failures by finite element modeling (FEM) (See: Enright, Introduction). McClung teaches to Enright because McClung specifically teaches using fracture mechanics in the FEM model for comparing statistics in the probability of failure

computations. (See: McClung: pages: 8-14) Further, the level of skill required by an artisan to realize the claimed limitations of the present invention is clearly established by both references. (See: Enright/McClung, Abstracts) Accordingly, a skilled artisan having access to the teachings of Enright and McClung, would have knowingly modified the teachings of Enright with the teachings of McClung (or visa versa) to realize the claimed elements of the present invention while reducing the cost and development time.

Per dependent claims 2-4, 8-11: Enright teaches failure due to fatigue and the use of probabilistic random variables as noted above (See Enright: page 1, para: 5). As also noted above, Representative Volume Elements (RVE) are commonly used in FEM modeling, and hence would have knowingly been incorporated by a skilled artisan to represent a microstructure failure model of component life. (See: Smit, para: 3, for example). Enright also teaches the use of Monte Carlo probabilistic methods (page 4, para: 1).

Per dependent claims 12-13: McClung teaches spatial correlation of similar geometric regions (pages: 8-14) and would have knowingly been incorporated by a skilled artisan using the reasoning previously cited above.

Regarding independent claim 19: Enright teaches a method, system, and apparatus (DARWIN) for predicting the failure of a component (structure) by representing a component element within a Finite Element Model (FEM) and subsequently identifying node stresses by analyzing the FEM model. (page 1, para: 3,

page 3, para: 3-5, Tab. 1) Representative Volume Elements (RVE) are commonly used in FEM modeling, and hence would have knowingly been incorporated by a skilled artisan to represent a microstructure failure model. (See: Smit, para: 3, for example) Enright further discloses simulating a structures life (in this case a rotor) to predict failure (page 4, para:2 to page8, para: 1, Figs. 5-9) and using model statistics and probability. (Also see: Abstract, Introduction, Figs. 2, 4, 5-7, page 1, para: 2)

Enright does not explicitly teach fracture mechanics in comparing the statistics to a probability of failure criteria.

McClung also teaches a method and system for predicting failure of a component represented in a FEM model inclusive of stress modeling and analysis and simulating component life. (pages: 1-7) More importantly, McClung teaches the use of fracture mechanics (crack growth mechanisms) and considers the spatial correlation of regions for different geometries and damage mechanisms in calculating (by comparison) a component probability of failure. (pages: 8-14)

It would have been obvious to one having ordinary skill in the art at the time the claimed invention was made to modify the teachings of Enright relating to for predicting the failure of a component by representing a component element within a Finite Element Model (FEM), with the teachings of McClung relating to the use of fracture mechanics in comparing the statistics to a probability of failure criteria, to realize the claimed invention. An obvious motivation exists since, in this case, the Enright reference teaches to the McClung reference, and the McClung reference teaches to the Enright reference. Specifically, both Enright and McClung teach failure analysis using FEM

models and the DARWIN system and are used in the same technological arena as noted above. Enright teaches to McClung because Enright teaches modeling component failures by finite element modeling (FEM) (See: Enright, Introduction). McClung teaches to Enright because McClung specifically teaches using fracture mechanics in the FEM model for comparing statistics in the probability of failure computations. (See: McClung: pages: 8-14) Further, the level of skill required by an artisan to realize the claimed limitations of the present invention is clearly established by both references. (See: Enright/McClung, Abstracts) Accordingly, a skilled artisan having access to the teachings of Enright and McClung, would have knowingly modified the teachings of Enright with the teachings of McClung (or visa versa) to realize the claimed elements of the present invention while reducing the cost and development time. It would further be obvious that the DARWIN system disclosed by Enright and McClung be inclusive of a CPU with input device, output device, memory, and computer instructions for executing the elements noted above.

Per dependent claims 20-22, 26-29: Enright teaches failure due to fatigue and the use of probabilistic random variables as noted above (See Enright: page 1, para: 5). As also noted above, Representative Volume Elements (RVE) are commonly used in FEM modeling, and hence would have knowingly been incorporated by a skilled artisan to represent a microstructure failure model of component life. (See: Smit, para: 3, for example). Enright also teaches the use of Monte Carlo probabilistic methods (page 4, para: 1).

Per dependent claims 30-31: McClung teaches spatial correlation of similar

geometric regions (pages: 8-14) and would have knowingly been incorporated by a skilled artisan using the reasoning previously cited above.

Claim Rejections - 35 USC § 102

The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

> A person shall be entitled to a patent unless –
>
> (b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.

4. Claims 32-37 are rejected under 35 U.S.C. 102(b) as being anticipated by "Future Research Trends in Metal Plasticity for Simulation of Metals Processing and Life Cycle Engineering", D.L. McDowell, Research Paper, Georgia Institute of Technology, September 1999.

<u>Regarding claims 32-37</u>: McDowell discloses techniques for simulating the grain orientation and slip of microstructure grains (page 3, para: 1, page 3, para: 2) using probabilistic methods (Monte Carlo etc. page 7, para: 1) inclusive of the orientation distribution of grains (page 7, para: 2-4, page 9 para: 3) and other microstructure attributes for metal alloys (page 1, para:1) using grain orientation and slip model equations (page 13, para: 3) relating to the material stress direction (page 4, para: 3). McDowell further discloses modeling (simulating) effects of separation and sliding for various microstructure scale grain sizes (page 10, para: 3) and strain accumulation leading to progressive deformation and failure. (page 10, para: 2)

Allowable Subject Matter

5. Claims 5-7, 14-18, and 23-25 are objected to as being dependent upon a rejected base claim, but would be allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claims. In this case the prior art does not disclose or suggest the specific sequence of steps for characterizing damage interaction, creating/finding a microstructure failure model base on a damage mechanism, damage mechanism model groups, or linking the models to the RVE microstructure as recited in dependent claims 5 and 23.

Conclusion

6. The prior art made of record and not relied upon is considered pertinent to applicant's disclosure. Careful consideration should be given prior to applicant's response to this Office Action.

U.S. Patent 6,301,970 issued to Biggs et al teaches component failure prediction using FEM.

U.S. Patent 6,226,597 issued to Eastman et al teaches component failure prediction.

"Toughness of Heterogeneous Polymeric Systems, a Modeling Approach", Smit et al, research paper, Eindhoven University of Technology, ISBN 90-386-0750-4, June 1998 teaches using a representative volume element (RVE) in an FEM model of a microstructure for stress analysis.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Fred Ferris whose telephone number is 571-272-3778 and whose normal working hours are 8:30am to 5:00pm Monday to Friday. Any inquiry of a general nature relating to the status of this application should be directed to the group receptionist whose telephone number is 571-272-3700. If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Jean Homere can be reached at 571-272-3780. The Official Fax Number is: (703) 872-9306

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